IN THE SPECIFICATION:

Only paragraphs **[0002]**, **[0004]**, **[0017]**, **[0018]**, **[0019]**, **[0020]**, **[0027]**, **[0031]**, and **[0034]** in the Specification have been changed.

Clean version is presented below:

[0002] Field of the Invention: The present invention relates to a method and apparatus used in transfer molding to provide a flowable resin to a substrate having one or more semiconductor devices thereon for the packaging thereof. More specifically, the present invention relates to a method and apparatus used in transfer molding to prevent voids and air pockets in a flowable resin provided to a substrate having one or more semiconductor devices thereon for the packaging thereof.

[0004] However, as shown in drawing FIG. 1, when the resin 1 flows to fill the horizontally oriented cavities 3, the flow is usually not uniform due to various design factors of the semiconductor device 32 and lead frame 33 and gravity acting on the resin 1. As a result, the fronts 1a, 1b of the resin 1 flowing above and below the semiconductor device 32 will often meet above the semiconductor device 32 instead of at the vent, causing the molded package to have undesirable air pockets and/or voids 2, as shown in drawing FIG. 2. These types of defects not only degrade the outer appearance of the molded package, but also produce reliability problems with respect to its resistance to thermal shock and exposure to humidity and other contaminants.

[0017] FIG. 5 is a cross-sectional side view of a substrate in a vertically oriented mold cavity, illustrating resin flowing in the vertically oriented mold cavity in a substantially vertical upward direction, in accordance with the present invention;

[0018] FIG. 6 is a cross-sectional side view of a substrate in a vertically oriented mold cavity, wherein the cavity includes protrusions configured to contact bond pads or contacts of the substrate, and illustrating resin flowing into the vertically oriented mold cavity in a substantially vertical upward direction, in accordance with the present invention;

[0019] FIG. 7 is a cross-sectional side view of a ball grid array substrate positioned in a vertically oriented mold cavity, illustrating resin flowing upwardly into the vertically oriented mold cavity, in accordance with the present invention;

[0020] FIG. 8 is a cross-sectional side view of an assembly, including a carrier substrate and a semiconductor device flip-chip bonded thereto, in a vertically oriented mold cavity, illustrating resin flowing in the vertically oriented mold cavity in a substantially vertical upward direction, in accordance with the present invention;

[0027] In the present invention, the vent 20 is located substantially at an upper portion 4 of the cavity 10 with the gate 16 preferably located at a lower portion 6 of the cavity 10. In particular, as shown in drawing FIG. 4, it is preferable that the mold cavity 10 be oriented substantially vertical and longitudinal along a vertical plane 30 which is substantially perpendicular or at substantially 90° from a horizontal plane 28. As such, when the resin 24 fills the cavity 10, the flow fronts 26 and 26′ rise vertically toward the vent 20 at substantially the upper portion 4 of the cavity 10. Further, the flow fronts 26 and 26′ rise substantially at the same rate due to the force of gravity acting on the flow fronts 26 and 26′. Therefore, gravity helps control the flow fronts 26 and 26′ to equalize and become substantially one flow front prior to reaching the vent 20 at the uppermost portion 4 in the cavity 10, allowing the resin 24 to substantially fill all portions of the cavity 10 and forcing air or gases within the cavity 10 through the vent 20 without substantially creating air pockets and/or voids in resin 24. Even if the flow fronts 26 and 26′ rise at different rates prior to surpassing an edge 34 of the semiconductor device 32, the flow fronts 26 and 26′ will substantially equalize each other after reaching the uppermost edge 34 of the semiconductor device 32 due to the force of gravity acting thereon. In this manner, gravity provides a more uniform flow front, wherein gravitational force induces the filling of spaces where potential air pockets and/or voids were conventionally formed in the cavity 10. Therefore, the present invention substantially prevents the conventional problems of voids and air pockets as previously discussed. In the present invention, the fluid molding material is caused to flow over any desired substrate having any type and number of semiconductor devices attached thereto in a substantially vertical direction, such as a substrate and semiconductor device(s) being located in

the mold cavity, at approximately ninety degrees (90°) with respect to the horizontal axis of the mold cavity.

[0031] A fourth embodiment of the present invention is illustrated in drawing FIG. 7, depicting resin 24 filling the cavity 10‴ of a transfer mold 5‴ in a substantially vertical direction to cover at least the second surface 55 of the substrate, in this case a flip-chip type semiconductor die 52. Of course, the cavity 10‴ may alternatively be configured to hold and facilitate encapsulation of an individual semiconductor die 52, a plurality of individual dice, or a wafer or other large-scale substrate with a plurality of semiconductor devices thereon. The fourth embodiment is similar to the second embodiment in all respects, except the semiconductor die 52 includes conductive structures 56, such as balls, bumps, pillars, or columns including a conductive material such as a solder, other metal or metal alloy, a conductive epoxy, a conductor-filled epoxy, or a z-axis conductive elastomer, predisposed on and protruding from the bond pads thereof. Additionally, the second half 14‴ of the transfer mold 5‴ may include a plurality of recesses 58 formed in and configured to receive portions of conductive structures 56 so as to prevent resin 24 from completely covering the same.

[0034] A sixth embodiment is illustrated in drawing FIG's. 9 and 10, depicting resin 24 filling a gap 72 between a semiconductor die 52 and a substrate 64, such as a carrier substrate or an interposer (i.e., a flip-chip assembly 62) in a substantially vertical direction. In the sixth embodiment, at least one barrier 76 is disposed adjacent the periphery 51 of semiconductor die 52 and includes a space or opening 78 formed therein and configured to facilitate dispensing or injecting the resin 24 into a gap 72 between the semiconductor die 52 and the substrate 64. Further, as a dispenser 82 provides resin 24 through opening 78, the resin 24 preferably fills the gap 72 between the substrate 64 and die 52 via capillary action, although positive or negative pressure may be applied to resin 24 as known in the art to accelerate the flow of resin 24 into the gap 72. As such, the at least one barrier 76 is provided to contain the resin in the gap 72 between the semiconductor die 52 and the substrate 64. Accordingly, as in the previous embodiments, it can be well appreciated that gravity provides a more uniform flow front 26, wherein the gravitational force induces the resin 24 to fill in spaces above solder bumps 66 where potential air

pockets and/or voids are conventionally formed around the solder bumps 66 in the gap 72 between the substrate 64 and semiconductor die 52.